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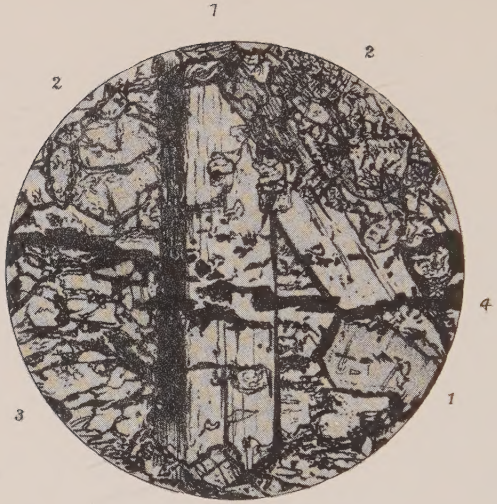

Fig. 1

Fig. 2.

Mintern Bros. Chromo lith.

Glaucophane-eclogite from the Val d'Aoste.

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No. 32. JULY 1886. Vol. VII.

On a Glaucophane-eclogite from the Val d'Aoste.

By Prof. T. G. Bonney, D.Sc., LL.D., F.R.S., Pres. G. S., &c.

Plate I.

[Read December 8th, 1885.]

THE number of localities at which glaucophane has been discovered is still comparatively small, so that it may be of interest to add another and to describe the microscopic structure of a rock in which this interesting variety of hornblende occurs.

The carriage road between Verrex and St. Vincent in the Val d' Aoste mounts along the left bank of the Dora Baltea, which, in one part, often called the defile of Mont Jovet, is scarped and craggy. The steepest part of the ascent is between the hamlets of Berrioz and Nus (?). I was walking up this, one day in July 1885, in company with my friend the Rev. E. Hill, F.G.S., when my eye fell upon a rock, which I at once recognised as a variety of eclogite, composed chiefly of small reddish garnets and dull-green hornblende. We secured specimens, though with considerable difficulty, for the rock was very tough; made a few observations and passed on. Next morning, as I was preparing to pack up my specimen, I noticed a peculiar violet-blue tint on its surface, which in certain positions became

very marked. Probably the glittering dispersion caused by the strong sunlight had been the reason of my overlooking the colour on the previous afternoon. I at once felt certain that the tint indicated the presence of glaucophane, and on my return to England lost no time in having slices prepared for microscopic examination, which showed that mineral to be present in no small quantity.

The rock has a slightly foliated structure and a rather rough fracture. The garnets (which project on slightly weathered surfaces) commonly vary from about the size of a hemp seed to that of a mustard seed, but are occasionally a little larger or smaller. Their outline is not very sharply defined, their colour a plum-red or brownish-red. The (dominant) hornblendic constituent appears to be very slightly fibrous in texture, and to be an intimate mixture of a dull-green variety and one of a violet blue, inclining very slightly towards cobalt-blue; the prevalent colouring depending to some extent on the angle at which light is incident, and the blue tint being much more conspicuous on the freshly fractured surfaces. Besides this there is a fair amount of yellow-green epidote, more conspicuous on slightly weathered surfaces; and some scales of a silvery white mica. Examination with a lens shows also some tiny streaks of a minutely granular mineral, of a reddish brown colour, but paler than the garnet.

The following is a microscopic description of the rock, of which I have had six slides prepared from fragments taken from two different parts of the mass.

(1.) *Garnet.* Size commonly less than ·1 in. in diameter. The mineral is granular in outline, an external angle being seldom well-defined; much cracked, and showing occasional cleavage. Colour a pale wine-red. Minute microlithic enclosures not unfrequent; sometimes of glaucophane or hornblende, often of dark dust. It is, however, possible in certain cases that these are subsequent infiltrations.

(2.) *Hornblende.* On the whole the most abundant mineral, occurring in rather small, somewhat elongated crystals, in clustered groups, with a general uniformity of position, as if the mineral were a secondary formation developed under a pressure definite in direction. The crystals very often do not exhibit cleavage, and are not markedly dichroic. A distinct green in colour.

(3.) *Glaucophane.* The grains vary in external form, sometimes they are filmy and irregular in outline, sometimes the external faces are well defined. The former are interstitial with other minerals; the latter, though occasionally interrupted by a garnet, are often perfectly regular, as though developed

in a yielding matrix. Usually they are fairly free from inclusions, though sometimes they contain films of a chlorite or a more normal hornblende, or (more frequently) granules of a brown mineral to be described presently. The longitudinal sections of the glaucophane are often from ·04 to ·06 inch long, the transverse sections about ·03 inch. The cleavage parallel to ∞P is often very well defined, but the mineral has sometimes a slightly fibrous structure in longitudinal sections. With transmitted light the colour varies from a beautiful tint of violet-blue in longitudinal sections to a pale violet in tranverse sections. With polarised light the glaucophane, in longitudinal sections, with vibrations parallel to the *c* axis, gives a clear ultramarine blue, and, with perpendicular vibrations, a pale purplish or puce tint. In transverse sections, with vibrations parallel to the clino-diagonal plane it gives a pale, but slightly ruddy, sap-green, and, with vibrations perpendicular to it, a rich violet. It is difficult to estimate the amount of glaucophane in the rock, but it is rather less abundant than the hornblende and the garnet, and forms perhaps about one-sixth of the whole mass. From the fact that the glaucophane has not seldom a regular crystalline outline, as may be seen from the figures, and in other cases occupies cracks which traverse the garnet, I am of opinion that it is later in date than either that mineral or the normal hornblende, and probably than the compression which the rock has evidently undergone.

(4.) *Epidote*, rather irregularly distributed in small grains, often rectilinear in outline. This mineral calls for no special remark.

(5.) *Mica*. This mineral is not abundant, and is rather irregularly distributed in the slides; with transmitted light it has a slight tinge of green; I consider it to be one of the hydrous micas, and if not exactly a secondary product at any rate in an altered condition. Small colourless belonites are sometimes included in it.

(6.) *Impure Sphene (?)*. This mineral occurs in granules, occasionally assuming an outline which suggests a monoclinic crystal. Their diameter does not generally exceed ·005 inch. They occur in rather streaky elongated clusters, which seem to cut through the other constituents of the rock, and have been formed, I think, at any rate in part, in minute cracks developed by subsequent pressure. This mineral varies from moderately translucent to opaque, being in the former case a resin-brown. I cannot precisely identify it by microscopic examination alone, and it would be no easy task to isolate a sufficient quantity for chemical analysis, so I must leave this constituent undetermined, merely stating that I conjecture it to be a titaniferous mineral, and to contain iron. I have occasionally met with it before, and think I have seen it named zircon in some purchased

slides, but doubt this identification. Rutile is said to occur in glaucophane-rock from the Val Tournanche.

In one of the specimens, the glaucophane, and I think some of the hornblende, is bordered by a dull green microlithic mineral which appears to be nearly related to chlorite; this I have no hesitation in considering a decomposition product, so that I deem a further description needless for my present purpose.

Petrological Relations. This glaucophane-eclogite is associated with a set of schists generally rather fine-grained; these by the Swiss geologists are referred to the great series of bedded schists which form the highest group in the truly metamorphic rocks of the Alps. They are, in the main, the "*Schistes lustrées*" of some authors; the *grauekalkhaltiger schiefer* and *grüner schiefer* of the Swiss Geological Survey map, with which schistose serpentines are not seldom associated. The commonest rocks of the group are quartz-mica schists, often calcareous, and sometimes passing into beds of crystalline limestone or dolomite, but in certain districts, as on the southern slopes of the Pennine and in the Graian Alps, green schists are important members of the group, occurring, I think, rather in the lower part. Some of the green rock I believe to be only serpentines* crushed and rendered schistose by subsequent pressure, but others are chloritic and hornblendic schists, apparently of sedimentary origin. The series in this part of the Dora Baltea valley has a general south-west to north-east strike and a variable dip (not generally high) on the northern side; much evidence, however, of subsequent disturbance is afforded by corrugations and slickensided fractures. Below the glaucophane-eclogite† we have a calc-mica schist with some quartz, apparently interbedded with a green hornblende-epidote schist; above it a very fissile green schist, probably similar to that below in mineral composition, followed by a rock which is very possibly a crushed serpentine, and then a green schist, consisting chiefly of green hornblende and colourless mica with a little quartz and a few garnets. The eclogite varies a little in the coarseness of its constituents. It exhibits, as I have said, a slight foliation, and appeared to be interbedded with the schists above and below; but the former character is of little value in a region such as the Alps, and the evidence was not sufficient to determine the latter point. The rocks, on the day of my visit, were almost "whitewashed" with a thick coating of dust, and the time at my disposal did not allow me to endeavour to trace the eclogite up or down the craggy

* The word is used in its strict sense.

† Unfortunately I omitted to record the thickness of the exposure, but it is certainly several feet at least.

hillside, for this might have occupied some hours, and I could do no more without altering the plan of my journey.*

Comparison with other Specimens of Glaucophane.—I discovered a glaucophane rock on the sea shore at Pegli, a little west of Genoa, in the year 1878, and gave some account of it the following year.† As, however, it was rather cursorily noticed, for the paper was mainly on serpentines and the rocks associated with them, I will venture to give a rather fuller description.‡ The rock microscopically is a dull green "greenstone," rather minutely crystalline, with a rough fracture, tough, heavy, and evidently rich in a hornblendic constituent. It appears in the field to become in parts more coarsely crystalline, when it resembles "some of the gabbros on the Cornish coast, except that the pyroxenic constituent is less metallic and the 'saussurite' less abundant" (unfortunately I did not bring away a specimen of this variety of the rock). Microscopic examination shows that secondary mineral changes have taken place to a great extent. The felspathic constituent has been almost wholly obliterated, being replaced by a minutely granular, dusky looking mineral, associated with flakes of actinolite. A clear mineral in larger grains occurs occasionally, which may in some cases be felspar, but perhaps is more likely to be some hydrous silicate, or possibly now and then secondary quartz. The pyroxenic constituent has been converted into hornblendic minerals, as is commonly the case in gabbros; but here and there the close cleavage of the original diallage can still be discerned, and where this is most marked the mineral is dusty-looking, almost opaque, without definite characters. This is often bordered or traversed irregularly by glaucophane, and occasionally by ordinary pale-green actinolite. The glaucophane is abundant, and it appears to be a secondary constituent of the rock; most of it is more or less fibrous or "actinolitic" in structure, as is usual in the gabbros where the hornblende has resulted from the alteration of an original pyroxenic constituent—but (as may also be seen in such rocks)

* I hope the next visitor will endeavour to work this out. As it may prove, if it can be done, a rather long task, he had better sleep at St. Vincent, where the hotels are much better than at Verrex: if the roads are dusty he had better take a brush with him. He cannot miss the locality, it is on his left hand as he descends the high road.

† *Geol. Mag.* Dec. II. Vol. VI. p. 363.

‡ Mr. G. H. Williams (N. J. 1882, Bd. II. p. 201) notices a rock which he believes to be from this locality (of this I am doubtful), and intimates that I should have called it an *amphibolite*. As in 1879 it was not even certain that amphibolite denoted an igneous rock (I am not aware that there is harmony in its use now), and as I was satisfied the rock was of igneous origin, and had once been a gabbro, I preferred to call it (as I shall continue to do) a glaucophane-gabbro.

we occasionally find a grain (having usually its external outline rather ill-defined) where the characteristic cleavage of hornblende is very well marked; colour with transmitted light shades of violet blue inclining to ultramarine, with polarised light as described above, but perhaps a little less vivid. The slide contains a few granules of an iron oxide, but parts of some of the diallage crystals are replaced by an almost opaque mineral resembling a decomposed ilmenite. Glaucophane also occurs in a singular fragmental rock in the same neighbourhood, as to the origin of which I have not been able to come to any satisfactory conclusion.

Glaucophane seems to occur rather frequently in the central part of the Pennine Alps, for it is recorded as discovered at another locality, Champ de Praz, in the Val d'Aoste, also at Brozzo (near Ivrea) and in the Val Locarno (Stelzner, *Neu. Jahr.* 1883, Bd. I. p. 211). Strüver gives an analysis of the mineral from Brozzo, to which he gives the name *Gastaldite* (which, however, is now replaced by the older name glaucophane) (*N. J.* 1876, p. 664).* Glaucophane has also been found in the Val Tournanche near the Matterhorn (Cossa and Strüver, *N. J.* 1880, Bd. I. p. 162), and in pebbles at Germagnano (Williams, *N. J.* 1882, Bd. II. p. 201). On the north side of the Alps it is recorded from near Zermatt (Bodewig, *Pogg. Ann.* CLVIII. 1876, p. 224), and as an erratic in Switzerland (Stelzner, *N. J.* 1883, Bd. I. p. 208). Besides the original locality, the Island of Syra (Lüdecke *Zeitsch. deutsch. geol. Ges.* XXVIII. p. 248), it has been found by Dr. C. Barrois at the Isle de Groix (Morbihan), Brittany (*Ann. Soc. Geol. Nord.* XI. p. 45).

The composition is exceptional, the amount of Al_2O_3 being extraordinarily large, as will be seen from the analysis subjoined (Strüver). (The highest percentage in a list of 52 analyses of hornblende, given by Dana in his *System of Mineralogy* (pp. 238, 239), is 17·59; the specimen came from Bilin in Bohemia.)

SiO_2	=	58·55
Al_2O_3	=	21·40
FeO	=	9·04
MgO	=	3·92
CaO	=	2·03
Na_2O	=	4·77
K_2O	=	trace.
		99·71

* See also *Atti R. Accad. Lincei*, Ser. 2, Vol. II. p. 333. Here it is said that the specimens from the Val d' Aoste "furono estratti dagli affioramenti dei depositi cupriferi di Champ de Praz e S. Marcello." I cannot find on my maps the former place, but, as the latter is between Chatillon and Aosta, conclude the above localities are different from that which I have described. In this memoir the optical properties are described.

The glaucophane rock from Syra, in the British Museum Collection,* is a fine-grained light-grey to brownish schist (not markedly fissile) with conspicuous crystals of glaucophane, roughly about ·1″ × ·3″. Under the microscope the ground-mass mainly consists of a white mica interbanded with small granular quartz—much resembling, in fact, one of the quartz schists which occur in the Alpine series rather low down in the upper group of schists, *i.e.* probably not very far away from the horizon of the glaucophane rock described in this paper; the external angles of the glaucophane crystals are generally well-defined, though sometimes imperfect. They do not, however, seem to have been subjected to pressure, though the ground-mass does. The crystals are dark in colour, and the characteristic violet hue is not always perceptible. Glaucophane occurs in another schistose rock from the same island, in which is much of a mineral resembling impure epidote. The specimen figured by MM. Fouqué and Lévy (*Roches Eruptives*, Plate I. Fig. 2) is less markedly foliated than the British Museum specimen. In the Isle de Groix† the glaucophane occurs in no great abundance with greenish mica, epidote, garnet, hornblende and but little quartz. The rock has all the characters of a schist. The glaucophane crystals are of no great size, but fairly abundant in a specimen from Canton Valais (exact locality uncertain), with quartz, actinolite (?), and are often scattered about in patches of a chloritic mineral. The largest and most characteristic glaucophane crystals are in a rock from the neighbourhood of Zermatt; here their structure suggests to me the possibility of the replacement of a diallage. Comparing my own specimens with the above, I may say that the glaucophane in them is as characteristic as in any, and the crystals are only surpassed in size by those from Syra and Zermatt. I may add that in the majority of the above specimens the glaucophane appears to me to be more probably a mineral formed late rather than early in the rock's history.

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* I am indebted to the President and Mr. T. Davies for the opportunity of studying the slides, &c. mentioned in this paragraph.

† I have a specimen of this and of the Syra rock in my own collection, for which I am indebted to Prof. Judd.

DESCRIPTION OF PLATE I.

Fig. 1.—Section of glaucophane-eclogite, exhibiting (1) glaucophane; (2) garnet, in a ground-mass chiefly composed of green hornblende (3); traversed by an irregular line (4) of the brown mineral (? impure sphene). In this section the principal crystal of glaucophane is cut parallel with the vertical axis.

Fig. 2.—Section of glaucophane-eclogite, exhibiting the same minerals, numbered 1, 2, 3, as before. The principal crystal of glaucophane is cut transversely to the vertical axis, and exhibits the characteristic outline and cleavage of a hornblende crystal. The sections are drawn with ordinary transmitted light, and the dichroism of the mineral is well indicated by the difference between the blue tint of the upper and the purple tint of the lower crystal. In each case, it may be noted, grains of the green hornblende are included in the glaucophane.

Magnified 27 diameters.

I have to thank Mr. Felix Oswald for kindly making the drawing.

T. G. B.

On Idocrase and other Minerals recently found near Zermatt.

By W. J. Lewis, Professor of Mineralogy in the University of Cambridge.

[Read December 8th, 1885.]

SOME Zermatt Guides (Joseph Taugwalder and his brother) made, on a recent excursion up one of the mountains (Pollux ?) in the neighbourhood, the discovery of some very interesting crystals of idocrase and red garnet.

The idocrase crystals are of a dark sherry colour, and are developed in simple forms, the prism-planes $m\{110\}$, $a\{100\}$, and the base $c\{001\}$, being well developed. The edges $[cm]$ are truncated by narrow planes $u\{111\}$, and at the corners small planes $i\{312\}$ are sometimes found. The prism planes are deeply striated, and at the same time the c plane shows more or less coarse squares, which sometimes seem to belong to independent crystals. The sides of the square are parallel to the $a\{100\}$ faces. The crystals have, therefore, much the character of a bundle of thin pyramidal crystals united together in parallel positions.

Both faces c are generally present, but one of them is bright, whilst the other has commonly an incrustation on it or seems to have been corroded. The larger crystals are as much as 30 mm. long by 28 mm. across. One fine specimen is about 30 mm. high, 28 mm. along one normal to m, and only 13 mm. in the direction perpendicular to these. In this latter crystal both c planes are bright, and the square markings are unequally developed on different portions of the same face.

The crystals sometimes show at one extremity a curious change similar to that common in beryls from the Mourne mountains, and which seems to be a result of corrosion.

The almandine crystals associated with the former mineral are of a bright deep red, they consist of the rhombic dodecahedron $\{110\}$ together with the forms $\{211\}$ $\{321\}$. The faces $\{211\}$ are largely developed and much striated, and the faces $\{110\}$ are often reduced to narrow lines.

Orthoclase from Kilima-njaro, and Adularia from Switzerland.

By H. A. Miers, M.A.

[Read December 8th, 1885.]

Orthoclase from Kilima-njaro.

PROFESSOR BONNEY has described, in the British Association Report for 1885, the rock specimens brought from Kilima-njaro by Mr. H. Johnston, and has called attention to the peculiar form of the felspar crystals which are porphyritically developed in a rock referred by him to augite-andesite. It is at his suggestion that a more detailed account of these crystals is here attempted.

They are of a brown to yellowish-brown colour, full of cavities, and considerably weathered, and are so much rounded that it is impossible to determine their nature with certainty by means of the hand goniometer. They sometimes attain a length of 35 mm.

Two distinct habits of the crystals are shown in figures 1 and 2. In the former the angle *mm* was roughly measured as lying between 58° and 57° (in one case 61°), while the inclination of *y* to the edge *mm* is about

Fig. 1.

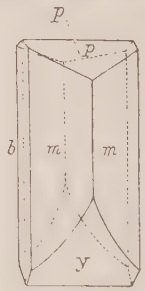

Fig. 2.

35°. *p* is generally found only as a cleavage face, and there is also a ready cleavage parallel to *b*. The form shown in fig. 2 is evidently a twin growth, for the cleavage surface is here repeated at the back of the crystal, which is now symmetrical about a plane truncating the edge *mm*. In this case the angle between the two cleavage faces *pp'* can be measured with some accuracy by the reflecting goniometer, and is found to be 52°20′.

If then the crystals are orthoclase they appear to be a combination of the forms $m = \infty P$ {110}, $y = +2P\infty$ {201}, $b = \infty P\infty$ {010}, and sometimes $p = 0P$ {001}, twinned on the orthopinakoid (100), that is to say according to the Carlsbad law, but distinguished by this peculiarity—that the individuals are united, not by irregular penetration or along the clinopinakoid, but along the orthopinakoid; in other words the plane of twinning is also the plane of junction.

To make sure that this is so sections were cut across one of the twin crystals in two directions, parallel to the cleavage planes p and b.

In the basal section the twin junction is seen to run across the crystal in an uneven line perpendicular to b, while the directions of extinction in the two halves are nearly the same, namely, parallel and perpendicular to b. The other section shows the two individuals clearly defined; the directions of extinction in each are nearly parallel and perpendicular to p (inclined at 5° to p), and are therefore inclined to one another at angles of 42°20′ in the two halves of the section. The usual appearance of the twin crystals is shown in fig. 3, one individual thinning off rapidly towards the prism edge.

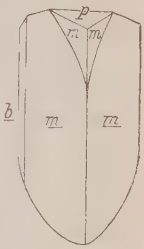

Fig. 3.

Finally, a section cut perpendicular to the cleavage p and examined in the polariscope, shows both optic axes symmetrically disposed about a plane parallel to b, their apparent angle in air being nearly 102° (sodium light).

In other words, the plane of the optic axes nearly coincides with the basal plane p, $2E = 102°$, and the first mean line is parallel to the plane of symmetry b.

There remains no doubt, therefore, that the crystals are orthoclase of most unusual habit, twinned according to the Carlsbad law, but united in such a way that the plane of twinning is also the face of composition.

It may be added that the sections show the crystals to be full of enclosures; but especially characteristic are small parallelepipedal spots of which the sides are parallel to the faces $p\ b\ y$. These may be cavities filled with decomposition products. Parts of the crystals viewed by polarised light exhibit a well-defined cross-hatching parallel to the pinakoid faces.

It has been pointed out to me by Mr. Teall that this orthoclase is similar to the felspar of the "rhomben-porphyr" from Christiania. The resemblance is very close, both as regards the habit and the mode of twinning (see *Mügge. Neues Jahrb. 1881* (II.), p. 107).

Adularia from Switzerland.

A crystal of adularia picked out from among some Swiss minerals by

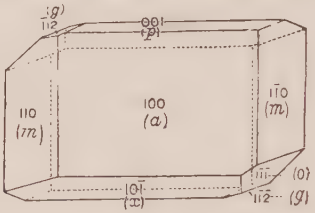

FIG. 4.

Mr. Davies because of its remarkable habit, is worthy of description. The form of the crystal is shown in fig. 4.

It is tabular owing to the large development of the orthopinakoid faces $a = \infty\breve{P}\infty$ {100}. The forms $m = \infty P$ {110}, $p = oP$ {001}, and $x = +\breve{P}\infty$ $\{\bar{1}01\}$ are symmetrically developed, but $o = +P$ $\{\bar{1}11\}$ and $g = +\frac{1}{2}P$ $\{\bar{1}12\}$ appear only on two opposite corners, giving the crystal a very asymmetrical aspect.

Both *a* and *g* are rare faces. *a* occurs on orthoclase from Striegau, Hirschberg, Elba, and Schiltach, and on adularia from Pfitschthal and Zillerthal. As a large face giving a tabular habit it has been described by F. Klocke (*Berichte der naturforschenden Gesellschaft zu Freiburg*, 1876, vi. Heft 4, p. 17), on orthoclase from Schiltach in the Black Forest. *g* was described by Weiss as interesting because apparently inconsistent with the symmetry of the system, since with his parameters it would have a horizontal edge with *b*, and would be equally inclined to the *m* faces. (In reality *gm* is 88°8′ on one side and 81°12′ on the other.) The face was established for the first time by Hessenberg in 1863 (*Min. Not.* v. p. 12) on adularia from St. Gothard.

On the crystal fig. 4 all the faces are fairly smooth and bright with the exception of *a*, which is unevenly striated parallel to its intersections with *m* and *p*, and is rounded towards the *m* faces.

On the Nomenclature of the Hydrocarbon Compounds, with a suggestion for a new classification.

By Andrew Taylor, F.C.S.

[Read May 21st, 1886.]

SINCE many of the minerals grouped as hydrocarbon compounds in Dana's Mineralogy have become extensively *exploited* for their commercial uses, allied questions in chemical geology and in their classification have bulked largely in scientific discussion. Thus their place as rocks or minerals in petrology has been mooted; for it is difficult to make out definite chemical composition or crystallographic form in many of the materials of the group now used for heating, lighting or paving. Notably the question, What is coal? has not been authoritatively removed from the range of scientific controversy—though the supply of the mineral which occasioned the great trial Gillespie *v.* Russel, nearly thirty years ago, was, until last year, considered exhausted. Diligently bored for to its exact position in the Scottish carboniferous series of rocks, no trace of it has been found except in its limited basin of four miles area or so around Torbanehill, Linlithgowshire. The centre of the basin, where the mineral was found, about two feet thick, has been thoroughly worked out for nearly fourteen years. But mining operations on the eastern and western extremities of the basin, both of which are much riddled by cross faults, have last year been rewarded by the finding of a few hundred tons, which have been sold on the Continent for gas enriching. So far, then, "Torbanite" and "Bathvillite" need not be regarded as extinct. But this nomenclature has not in the interval displaced the common use of "Boghead gas coal" or "Torbanehill Mineral" in popular use. Hence another plea against topographical names as applied to mineral species. The progress of the Scottish shale oil industry, which originated after the expiration of Young's Patent in 1863, when this mineral was considered exhausted, has thrown some side lights on its formation. During the "What is coal?" discussions of 1853 and the following years, it was clearly shown that the problem could only be fully solved by the study of individual mineral species of the class. Now oil shale, which at this period was hardly known either in commerce or mineralogy, presents at least many analogies to the Torbanehill material which formed the basis of Young's manufacture of

paraffin and mineral oils. The substances approach each other in streak, sectility, texture and fracture. They are alike clayey beds, yielding crude oil in varying degrees; for while Torbanite gave commercially one hundred gallons per ton, a substance is reckoned a workable oil shale if it yields thirty gallons per ton. The shale-refuse left by the new retorts, which utilise all the carbonaceous matter either as oil or subsequently as fuel, is a clay showing a large proportion of iron in its composition. The peculiarly white silicate of alumina left by Torbanite, the "ghaist" from which no old woman could obtain domestic services at her fire, was held at the trial to be its grand characteristic—distinguishing it from the coke-yielding cannel coals. Now, so far as the argument from geological position is concerned, Torbanite stands just above the upper limestone supposed to indicate the basis of the coal-measures, while the workable shales appear as yet confined to the lower carboniferous series. But these shales appear also bounded by a limited area, of which the Bathgate Hills form one extremity and the hills above Burntisland another. In the East of Fife, for instance, a totally different order appears to characterise the same geological horizon; for here "rum coals," or shales having all the other mineralogical characteristics of bituminous coal, appear.

The limited geognostic conditions prevailing in the first area generally from Edinburgh to the Bathgate Hills, appear to have been specially favourable to the appearance of a basin containing a seam of Torbanite, as well as of several others containing six workable shale seams. In faults, and other rock crevices, as well as intimately connected with the unique trap ridges, ozokerite, elaterite and other petroleum compounds have been found. Indeed "salse" action appears a probable explanation of some special petrological peculiarities both in the traps and their surrounding metamorphosed limestones and sandstones. And as petroleum flows are regular concomitants in the action of mud volcanoes, it is no improbable conjecture that beds of clay may have been saturated with oleaginous matter just as they were formed. Plant remains are abundant in the shales, as well as in the Torbane hill mineral. But the Broxburn oil shales are now also marked as the geological horizon for rare species of fossil fishes, and the old hypothesis that useful oleaginous matters in coal and shale were derived from vegetable eremacausis appears thus to break down. For were not the foul smells of some crude oils derived from such shales as the Kimmeridge beds regarded as proofs of their animal origin? According to the late Alfred Swaine Taylor a bituminous shale is a clayey substance with coaly, bituminous matter in it. A bituminous coal had an overplus of the oily principle, with little ash when burned,

and no clayey smell or appearance about it. "The greater or lesser quantity of clay makes the shale; and the greater or lesser quantity of bitumen, with a deficiency of clay or ash, makes the coal." Such was the gist of evidence given at the great trial, Binney and Company against the Clydesdale Chemical Company, in 1860. And, indeed, Professor Traill moved on similar lines when he designated the Torbanehill mineral, "Bitumenite," in 1853.* But manufacturing chemistry has demonstrated that these oil shales contain no bitumen, which belongs, along with petroleum, to the methyl series of hydrocarbons; and that their products belong to the ethyl or paraffin series, as also does ozokerite. At the great pitch Lake of Trinidad maltha hardens into asphalt or bitumen, while in another part of the lake the ozokerite compounds are simultaneously forming. Near at hand, too, lignite is being formed in proximity to an active mud volcano: all this apparently an extended protest against the opinion that coal can only be the product of decaying vegetation, or that a body in any respect approaching cannel coal can only have been formed through macerated leaves floating in shallow lakes. Bituminous shale became of legal importance when Du Buisson filed his English patent for distilling it, as he had previously successfully obtained paraffin oils from like material at Autun, in France. But the attempt to work this, in 1853, from the Kimmeridge shale was unsuccessful; so much so that attempts to utilise the Scottish oil shales shared much obloquy, because of anticipated foul smelling products like those from the Wareham deposit. Even now, the term "shale" is employed in law courts in such fashion as to show how a popular, easy-going, semi-scientific phrase may only darken knowledge—schist, slate and shale are defined in older books on rock-classification, such as that of Macculloch, as signifying a fissile structure characteristic of rock masses of most varied mineral constitution. The first two terms specially designated this in rocks of the so-called primary formations, while the term shale was confined to rocks having this structure, which can be seen alike in hæmatite and bituminous coal, and in rocks in the higher geological horizons. Torbanehill mineral was generally dug in cubical blocks; and last year isolated cubes mixed with unhardened clay were mostly dug out; but what is being presently mined shows a slaty structure. The term oil shale, recently introduced, appears too indefinite. Thus Professor Liversidge protests against the term "kerosene shale" being applied to the Torbanite of Hartley, New South Wales, now exported to Europe as a gas enricher.†

* *Trans. Roy. Soc. Edin.* Vol. 21.

† *Journ. Roy. Soc. New South Wales*, Vol. 14, p. 206.

It has not the characteristic lamellar or slaty structure of a shale; for even *in situ* the planes of stratification, quite invisible in hand specimens, are mainly apparent by the presence of layers or films of earthy matter. Like typical Torbanite, it gives a dull wooden sound when struck; the powder is light brown to grey, and the streak shining. It usually weathers to a light grey colour, the surfaces of the joints being often coated with a white film. Its broad conchoidal fracture, with concavities sometimes very deep in proportion to their breadth; its easy sectile characters, as well as its peculiar microscopic appearances, and its ash, sometimes practically white, all resemble the Torbanehill mineral. Many of its specimens show, when analysed, only half the fixed carbon of the latter, while it practically yields more gas and oil when distilled. Tourba from Brazil approaches Torbanite in many characters. It yields one hundred gallons crude oil per ton, burns readily in a candle, leaving the same matter as before, while the pure white residue of silicate of alumina is like that of Torbanite. Its greyish or brownish colour and felty texture reminds one of the streak shown by the knife on Torbanite or the "curley oil shale." According to Hartt, the section at Camamui Bay, Province of Bahia, Brazil, exhibits a variation from pure bitumen to arenaceous material interstratified with oil shales, suggesting the infiltration of oleaginous matter into sands or clays. In truth the three minerals just enumerated have similar properties, and are essentially one, though confused by inappropriate nomenclature. Professor Silliman proposed the name of *Wollongongite* for the New South Wales mineral; but this would only perpetuate a misleading topographical classification. The mineral at present shown as Boghead Coal in the Edinburgh International Exhibition, 1886, has a very yellow streak, indeed appears like consolidated Tourba; it is certainly not a coal. It is from the Alps above Vienna.

The grouping of the old class of the combustible minerals under the series of hydrocarbon compounds certainly indicates their usual geognostic relations. Thus Ozokerite, of the consistence of butter along with liquid oil, was found in a bore for shale at Broxburn in 1885, though not so abundantly as to inaugurate the mining of this Hungarian candle-stuff material in Scotland. Further, Mr. Galletly has described a bedded mineral, possessing all the external characters of Albertite, found interbedded in an oil shale seam at Addiewell, West Calder.* It yielded 88·75 gallons crude oil per ton, and its matrix only gave about 40 gallons. Like the Albertite of Canada and Ross-shire, as well as the surrounding

* *Trans. Edin. Geol. Soc.* Vol. II. p. 395.

shale, the large excess of hydrogen to carbon in its composition was similar to that in Torbanite. It approximated also in specific gravity to the last-named mineral. Now might not this family relationship be pictorially presented to the eye by graphic symbols? The result of retaining two or three old nomenclatures to describe minerals of such constant use, and with so many new relationships, is disastrous to specific designation; and consequently, a critical investigation of many of the individual species may lead to a new grouping, which might even alter the position of some presently recognised cannels and lignite. After all, symbols, even without the old names, might be employed to designate the present well-known compounds of the series. Whilst clearly demarcating the true bituminous and paraffin groups, a connection with the series of oxygen and the true hydrocarbons would have to be shown, as this undoubtedly occurs in nature. Thus a shale deposit at Blueskin, near Dunedin, New Zealand, shows such crystallised compounds of oxalates as Humboldtine and Whewellite imbedded in the main deposit, which yields about 50 gallons crude oil per ton. As the section is capped by basalt, it suggests a heat of 400° F., which is found necessary for the manufacture of wood-shavings into oxalic acid; and as similar associations of oxalates and brown coal or shale are known in Bohemia and Canada, such facts demand recognition in any scheme of natural classification. The natural relations betwixt bituminous coal, anthracite, graphite and the diamond would also have to be grouped. As discovery has progressed, it is certain that mere geological position has not influenced the genesis of the mineral series under discussion. Geognostic position, which may be duplicated from many geographic centres, appears to be the main requisite in the genesis of these minerals. The carboniferous system now only indicates where coal beds occur most abundantly; and oil wells and paraffin yielding deposits, or minerals like Torbanite, are now found in every geological formation.

The Metallic Ores of Chili.

By John F. Kerr, F.G.S.E.

(Communicated by Professor Ivison Macadam.)

[Read May 21st, 1886.]

THE ores which I have the honour to submit for your inspection were collected by me in Chili. They consist of numerous compounds of copper, silver, gold, &c., and represent the very varied minerals obtained in that country.

Besides the primary metal there is usually at least one secondary body of value present.

The proportion in which this secondary metal—I mean secondary as regards quantity—is present in metallic ores does not seem to be a mere chance affair, but seems to follow some law. My attention was directed to this matter by the silver ores from the district of "Lomas Bayas" near Copiapó. These ores contain gold in a certain proportion, not in relation to the gross weight of the ore but to the contents in silver. As you will see by Table I. the proportion is nearly 1 of gold to 100 of silver, and so near

Table I.

Assays of Ores of Silver and Gold.

Silver.	Gold.
.00385	·0000385
·003930	·0000400
·014715	·0001550
·015536	·0001640
·004516	·0000440
·005150	·0000500
·003566	·0000335
·002880	·0000308
·004320	·0000400
·004760	·0000500
·005040	·0000550
·003040	·0000250
·007900	·0000700
·008060	·0000700

does this proportion hold good that if the results of assay vary much from it the assay is distrusted, and often has to be repeated.

Table II. shows assays of copper and silver ores. In some of these

Cu is to Ag : : 1000 : 1
Some ,, ,, ,, : : 100 : 1
Some ,, ,, ,, : : 200 : 1

and other various proportions.

TABLE II.

Assays of Ores of Copper and Silver.

Copper.	Silver.
·422	·00042
·262	·00026
·285	·00033
·338	·00040
·198	·00180
·145	·00134
·109	·00115
·168	·00195
·591	·00030
·358	·00196

Table III. shows the proportions of silver to lead yielded by galenas

TABLE III.

Galenas.

	Lead.		Silver.
Finisterre	1	:	0·000923
Lozere	1	:	0·003929
Savoy	1	:	0·002745

from different parts; the decimals representing the proportions of silver to 1 of lead, being almost multiples of the lowest, as 1 : 3 : 4, and the decimal on Table IV. gives another multiple 15, so that we have silver to lead as 1 : 3 : 4 : 15 in these examples.

These relationships between the figures clearly point, I think, to some law regulating the proportions of different metals found in company in nature.

If we now turn to the composition of minerals, we shall find indications that this law has some reference to the combining weights of the metals.

Line 2 of Table IV., taken from Dana's Mineralogy, shows the average composition of Bournonite in ten samples from different parts of the globe.

TABLE IV.

Ratios of Equivalents.

	S.	Pb.	Sb.	Cu.	Fe.	Zn.	Ag.	Sn.	As.
Galenite	12·8	10	1	1		3	·14		
Bournonite ...	6	2	2	2					
Polybasite	10		1	1·5	0·08		12·8		·98
Enargite	9		1	7					2·00
Stannite.....	8			4	1	1		2	
Cubanite	12			3	7				
Chalcopyrite ...	11·2			1	1				
Barnhardtite ..	2·67			2	1				

The composition is nearly the same in all, and if we sum up the figures in each column and take the averages we find the average composition to be as shown. If we now reduce these averages to equivalents we get

the figures	S	Sb	Pb	Cu
	6·09	2·13	1·96	2·06
or say	6	2	2	2
which give	19·65	24·98	42·38	12·99=100

with which results we find the figures in the table to agree almost exactly, and the probable formula will be 2 PbS, Cu_2S, Sb_2S_3.

Table V. shows the composition of pyrargyrite in four samples, the averages of which are

	S	Sb	Ag
	17·455	23·10	58·90
and $\frac{\text{Average}}{\text{Equiv.}}$ =	5·453	1·894	5·454
or say	6	2	6
which give	17·71	22·51	59·78 =100.

Formula $3\,Ag_2S + Sb_2S_3$

TABLE V.

Pyrargyrite.

	S.	Sb.	Ag.
Average of Four Analyses...	17·155	23·1	58·9
Equivalents	S_6	Sb_2	Ag_6
In 100 parts	17·7	22·5	59·8

In both these minerals the sulphur is equally divided between the antimony and the other metals, one half being taken up by the antimony and the other half by the other metals present. In the pyrargyrite the second half of the sulphur is taken up by the only other metal present, viz. silver,

but in the Bournonite the other metals present, viz. lead and copper, lay equal claim to the second half of the sulphur and divide it exactly between them.

This would appear to indicate a tendency of some metals to claim a half or other large share of the non-metallic element in the mineral, and of other metals to share the other half or remainder as equally as possible among them.

We have examples of this in galenite, where lead is present in the largest proportion, and by taking up its proper share of sulphur to form PbS, will leave only a very small share of sulphur to divide up among the other metals, which have been able to get into the mineral by dividing this remainder among them; the zinc, however, claiming a preference, and putting in 3 equivalents, thus appropriating one half of the remaining sulphur, while the antimony, iron and copper are each represented by 1 equivalent.

In stannite, where copper supplies $4=\frac{1}{2}$ of the 8 metallic equivalents present, tin supplies $2=\frac{1}{2}$ of the remainder, and iron and zinc 1 equivalent each to complete the number. In this example the number of equivalent of the non-metal is the same as that of the metals. Another example is Barnhardtite, in which copper and iron are combined with sulphur in the ratios of 2 equivalents of copper to 1 equivalent of iron.

In chalcopyrite the same metals are combined with sulphur in the ratio of 1 of copper to 1 of iron. And in Cubanite the same metals are combined with sulphur in the ratio of 3 of copper to 7 of iron. In these few examples we see that the metals, in their joint combinations with non-metals, manifest preferences, but the preferences are not always on the same side, but, like good friends and good fellows, the metals mutually prefer one another even to the extent at times of taking equal shares; and they evidently do so by rule, whatever that rule may be.

Among the specimens on the table are a few rarities. One of these is a specimen of nitrate of soda, not the commercial substance, nor taken from the "salitreras," but taken from a much more elevated source, viz. from the Cordilleras at a height of about 14,000 feet above the sea. I have always understood that the source of Chili or Peruvian saltpetre is in the beds beneath the surface soil found in Peru and Chili. This is certainly the commercial source of nitrate of soda. But where do these beds get their supply from? The "salitreras" are found in flat, low-lying tracts of country, and are residues left by the evaporation of water whose journey towards the sea has been stopped at those places by the nature or formation of the ground; but where does the water get the

nitrate from? Some rocks contain soda which is gradually dissolved out as the rocks are decomposed by the weather, and carried away by rain and snow waters; and I have heard that it is converted into nitrate by the action of the nitrogen of the atmosphere. But this process is slow, and somewhat evenly spread over the face of the earth, and, I think, can scarcely account for the immense accumulations of nitrate in certain parts. Some may be formed in this way, but I think the water which supplies those "salitreras" must encounter the nitrate in some more handy form, and the sample before you shows what that form is. The genuineness of this sample I can vouch for, for I was present and saw it taken from its vein and have kept it carefully ever since.

At the height stated, about lat. 24° S, at the edge of a valley where the rocks are broken off abruptly, a "cateador" saw veins of some sort and a white crystalline substance in some of them, and, as it is these men's business and habit to pick up and examine everything they come across to find out whether it is of value or not, he picked off some, and, among other tests, he put a sprinkling on his lighted cigarette, when the increased combustion of the paper and tobacco at once told him what he had found. Well, in the rocks at this place there are a great many veins of this nitrate, between hard rock on either side; the length of the crystals in the bottle—about 1½ inches—shows the thickness of some of the veins from which they were taken, the crystals run transversely and have somewhat the appearance of lump sal-ammoniac. These veins were found cropping out here and there over a large area, and the thin soil in many places contained a large amount of nitrate. This specimen of nitrate is very pure, giving no indications of either sulphates or chlorides, and yielding to analysis 99·1 per cent. nitrate of soda.

Here, I think, we have the primary source—so far as it is possible for us to trace—of the great deposits of "salitre," in the "salitreras" of Chili and Peru. I don't think this source will ever become a commercial one, from the inaccessibility of its position. The cost of transit of supplies and of the nitrate, and the cost and difficulty of labour at that elevation, would be too great. It might pay if it had simply to be dug up as at the lower levels, but it would have to be mined and the veins followed in hard rock, so that for commercial purposes the source of supply will still be the "salitreras" of the plains. But to mineralogy the primary source must be the nitrate pure and crystalline existing in veins in the rocks at the higher and the highest elevations of the Andes.

Beds of salt are also found in the same locality referred to, and salt lakes at that great height supply huge blocks of salt for domestic and amalgamating purposes.

Another specimen is of vitreous native sulphur, broken off the outcrop of a vein of that substance 6 feet thick, which is seen to run for miles along the hillside at the same elevation.

There are also a few flat pieces of stone with which the mountain sides are covered as a thin layer over a great part of the same region. They will let you see the kind of rock existing there.

Another specimen is of sulphate of lime in needles, from a surface deposit in the desert of Atacama.

One specimen of silver ore contains ruby silver—pyrargyrite. Some contain native silver, and others are of different composition.

New Localities for the Mineral Agalmatolite, with Notes on its Composition.

By William Hamilton Bell, F.G.S.E.

[Read May 21st, 1886.]

THE rock-like mineral, known as Agalmatolite, derives its name from the Greek word αγαλμα, an image. It has also received the trivial name of Pagodite from Pagoda; it having been long used by the Chinese as the substance from which they carve their images and pagodas.

The earlier mineralogists confined the above names to hydrated silicates of alumina and potash, doubtless a product of the decomposition, or alteration, of orthoclase felspar; an intermediate stage in its conversion into the kaolin which is so abundant in the Celestial Empire.

Jameson, Phillips, Allan, Nicol, and all the fathers of mineralogy, admitted no other substance under the name. Nicol, who was a thoroughly well-read mineralogist, writes: "Many substances are named Agalmatolite which are really distinct;" and he clearly defines the species, which he makes the same as that called Agalmatolite in the present communication.

As the number of mineral analyses increased, we find magnesian silicates to have been placed in the same category, so that in the ponderous work of Dana the term has been more or less loosely applied to the following three different substances:—

First. The substance already noticed, the true Agalmatolite, which is a massive variety of Pinite.

Second.—A massive, and what has been called an indurated, variety of steatite. This is a hydrated silicate of magnesia.

Third.—A massive pyrophyllite, which is a hydrated silicate of alumina; differing from true agalmatolite in containing no silicate of potash or other alkali.

Professor Heddle, in his article on mineralogy in the *Encyclopædia Britannica*, again restricts the name Agalmatolite to the substance which originally was so designed; and it is well that it should be so restricted, as there is evidently much want of precision in the including of steatitic or magnesian minerals under the title.

There is a similar and a similarly misleading vagueness in the manner of using the term potstone, which in some of its properties resembles this.

The formula which Dr. Heddle gives for Agalmatolite, in his article in the

Encyclopædia Britannica, is $4Al_2O_3\ 2SiO_2 + 2K_2O\ 3SiO_2 + 2H_2O$; this gives in percentages 55 per cent. silica, 33 of alumina, 7·6 of potash and 5 of water.

The first discovery of Agalmatolite in Britain was by Dr. Heddle himself. In his *Geognosy of Scotland* he states that it occurs at several points in the bands of Laurentian gneiss in Sutherland, and especially at the end of the hill Kean-na-Binn, at Lua Yayi near Eriboll. In his *Geognosy of Scotland*, he gives his analysis of the mineral as found there :—

Silica	48·723
Alumina	31·58
Ferric Oxide	2·43
Magnesia	1·809
Potash	9·485
Soda	1·312
Water	5·752
	101·091

Hardness 2 to 3, cuts like slate pencil, specific gravity 2·8 to 2·9 ; and he makes the following remarks :—" It is many years ago since Dr. MacCulloch " threw out the suggestion that indurated steatite was of the nature " of Agalmatolite. Of several substances which might lay claim to such " a name as indurated steatite, this is perhaps that which most deserves it. " The above analysis shows the nature of the substance for the first time, " and probably proves Agalmatolite to be British. The definite informa- " tion thus obtained enables us to recognise as the same mineral certain " hitherto doubtful green masses which occur in the granitic rocks. " This substance, and its probable mode of formation, was also noticed by " Hay-Cunningham, who writes : ' Near the village of Rispond, the gneiss " makes a transition into a rock, composed of large concretions of serpen- " tine, between the two there being also every mode of gradation.' " Cunningham's serpentine is the Agalmatolite ; while I have to admit that " it is a mere conjecture (indeed the merest conjecture, seeing that pieces of " oligoclase equally large are rarely to be seen in these felspar bands) " which assigns the occurrence of the mineral to a change of oligoclase, " yet I have to say that I have not infrequently seen orthoclase passing " in its exposed surfaces into a substance not to be distinguished from this. " I instance the orthoclase of a dyke at Geo-na-Shermaig, of an infiltration " vein at Knock Dhu near Lairg, and probably a similar vein in the red " granite near Murdoch Head Quarry, in Aberdeenshire."

In 1881 and 1882 I was engaged on an inquiry into the serpentine rocks at Coyle Hill, near Ballater, Aberdeenshire. During my inquiry

I became acquainted with the constituents and appearance of these rocks, and was struck on finding, in the granite rocks in Ballater Pass, a mineral so similar in appearance to serpentine, that, like Hay-Cunningham, I called it serpentine, or serpentinous matter in the granitic rocks.

Ballater Pass runs between the hill Craigendarroch (at the foot of which Ballater lies) and another hill about 500 feet high, a mile north-east of Ballater. Both hills rise abruptly on each side of the Pass. The rocks on the east are a mass of confused blocks of coarse red granite; and it was when searching minutely for minerals which I had been told were to be found there, that I came across Agalmatolite. I was puzzled at its frequent occurrence, although in small quantities; but as serpentine is found everywhere in that neighbourhood, I allowed it to pass from my mind, but kept the specimens. It was only during the spring of last year (1885) that the finding of this mineral recurred to me, by reading the quotation I have made from Dr. Heddle's *Geognosy*. I was further interested in it on reading the report of Messrs. Peach and Horne on the question raised by Dr. Archibald Geikie on the north-west succession of rocks at Eriboll, and where this substance Agalmatolite is introduced. This report is found in *Nature*, in November 1884.

It occurred to me then that the mineral which I had found in 1880 in Ballater Pass was Agalmatolite, and on my showing my specimens to Dr. Heddle, he at once identified it as that mineral last summer. As I had no particular leaning to geological inquiry elsewhere, I returned to Ballater to prosecute my researches in this and other matters previously noticed there. I found this mineral in several parts of the Pass, but generally interspersed throughout the granitic rocks, and I sometimes found it running along a joint of the rock, as if it had, in a pasty semifluid state, been seeking an entrance there. On breaking up the rock, however, I never found that it had obtained an entrance. I have seen the mineral in this way run along a straight line of joint for yards.

My first search was in two quarries about 200 feet up a "ruckle"* of loose granite blocks, and the above was all I found there; but on going up the Pass to the west, about 200 yards from the stables of Monaltrie House, and crossing the Ballater Burn by a wattle bridge, I found it in great quantities; the mineral was also found in greater thickness, but generally seemed to cover the blocks; indeed, about this spot there was hardly a block that was not permeated by it or covered with it. I found it mostly at this point and in the rocks at the bottom of the *débris*, which

* "Ruckle" or "rickle," *anglicé*, a rough heap.

extended 200 feet up. I saw, however, green or yellowish matter like it on the solid rocks, at the very top of the cliffs, which were quite inaccessible to me.

When I returned from Ballater Dr. Heddle kindly asked me to go to St. Andrew's with my specimens. The result of our comparison of my specimens with those in his possession was that he expressed himself satisfied with their identity, and that he has little doubt that they would be found to be identical in substance with the Sutherland mineral. He, however, pointed out that from the intimate intermixture in my specimens with the silica, especially of the granitic matrix, it would form an almost impossible task to separate it sufficiently therefrom for analysis.

We found in one of the Supplements to Dana's Mineralogy that the mineral occurs at Glyden Bech, in Carnarvonshire; and after full consideration, we came to the conclusion that it was identical with my specimens, although the locality is new. The mineral may not, however, be of very rare occurrence, as Dr. Heddle stated that he had found it in Rubeslaw Quarry. Mr. Henry Mowbray Cadell, of the Geological Survey, also found it at East Ruadh, in Glen Fynne. Mr. B. N. Peach, also of the Survey, obtained long slabs of it from under the sea at Peterhead when the Harbour Works were being carried out there; Mr. MacConochie, also of the Survey, found it on the east side of Loch Garve, in Ross-shire, at the foot of Little Ben Wyvis; and Mr. Livingston, Rector of Fort William Academy, has obtained it in Glen Loy, near Banavie, on the road to Loch Arkaig.

In all these localities. including that in which I found it, the mineral is looser in structure than that from Eriboll, analysed by Dr. Heddle. Mr. Peach has also given me a piece from the same place; it has a more scaly appearance. This, however, would arise from its containing a minute quantity of what is probably mica.

Professor Ivison Macadam has kindly analysed the mineral as I found it, and also Mr. Peach's specimen from Kean-na-Binn, near Eriboll. (p. 28.)

The large amount of silica here obtained, certainly, at first sight, seems to throw doubt upon this being Agalmatolite. Mr. Macadam writes to me: "Looking at the care with which the material was picked, and the fact "that no silica was observable even when the rough sample was viewed "under high microscopic powers and with the polariscope, I am inclined to "consider the whole of the silica constitutional, and look upon the slight "variations in the proportions of silica shown by the analyses of your "samples as bearing out this opinion. I am inclined to the belief that this "mineral is formed under similar conditions to Agalmatolite, excepting "that silica has been present in greater proportions than is necessary to "form true Agalmatolite."

Dr. Heddle thinks this is equivalent to making it a new mineral, and observes that "if we regard it as a mere mixture of true Agalmatolite and "silica, that intermixture would amount to about two-thirds of the "whole, and that so large an amount of silica cannot be in union with the "basis in any true mineral." Dana, who places Pinite among the uni-silicates, remarks:—"Agalmatolite is like ordinary massive Pinite, but "contains more silica, so as to afford the formula of a bi-silicate, or nearly "so, and it may be a distinct species;" and in the last edition of his "work he gives no section of ter-silicates, remarking, "The species "hitherto arranged under that head being proved to have no existence."

Dr. Heddle, remarking on the above, shows that, with the exception of combinations with lithia and glucina, 55 per cent. given for Agalmatolite is about as high as in the most acid silicates, and thinks that the question of admixture with free quartz could be settled by an examination of the picked material with the polariscope, the high depolarising powers of quartz would enable its presence to be at once detected.

Analyses by W. Ivison Macadam, F.I.C., F.C.S., &c.

		Ballater Pass.		
	Kean-na-Binn.	No. 1.	No. 2.	No. 3.
Silica...	51·219	84·295	83·225	84·744
Alumina	33·046	8·593	9·991	10·131
Ferric Oxide ...	2·522	1·481	2·448	0·841
Magnesic ,, ...	0·331	2·112	1·112	1·301
Calcic ,, ...	0·141	1·586	1·077	1·013
Potassic ,, ...	6·495	2·045	2·125	2·325
Sodic ,, ...	0·184	0·163	0·132	0·154
Water	6·027	—	—	—
	99·965	100·275	100·110	100·509

On a New Locality for Agalmatolite.

By W. Ivison Macadam, F.C.S., F.I.C., &c., Professor of Chemistry, New Veterinary College, Edinburgh.

[Read 21st May, 1886.]

THE specimens to which this note refers were obtained from a precipitous cliff at the north-west end of Loch Maree, Ross-shire, called Creag Mhôr Thollie. The mineral occurs on the 1,000 ft. contour to the east or loch side of the Creag, and is in quantity. The analysis gave:—

Silica	63·256
Alumina	26·414
Ferric Oxide	1·832
Magnesic ,, ...	1·105
Calcic ,, ...	0·213
Potassic ,, ...	6·413
Sodic ,, ...	0·157
Water	0·508
	99·898

These results do not agree with the composition of the mineral as given in my analyses, in Mr. Bell's communication (p. 28), of the substance as found at Kean-na-Binn and Lua Yayi, nor with the Ballater substance, but are intermediate between the two. This I look upon as further proof that the mineral has no very defined chemical formula, but can be produced in the presence of an excess of silica, giving complex silicates. This body would fall under the title of "Siliceous Agalmatolite."

On some New Localities for the Mineral Diatomite, with Notes on the Chemical Composition of the Specimens exhibited.

By W. Ivison Macadam, F.C.S., F.I.C., Professor of Chemistry, New Veterinary College, Edinburgh, &c.

[Read May 21st, 1886.]

IN my previous papers on this subject* I have detailed various localities in which the mineral Diatomite has been found. Since the dates on which my papers were read various other localities have been discovered for the mineral, and I now beg to lay the details before the Society. The new samples are four in number, and are from—

1.—Golspie, Sutherlandshire.
2.—Loch Osabhat, Tolsta, Lewes.
3.—Auchnerran, Aberdeenshire.
4.—Presswhin, Aberdeenshire.

A fifth sample of a nodular mass from the Diatomite of Loch Kinnord, Aberdeenshire, has been analysed, and the results are included in this paper.

No. 1 Sample, from Golspie, was obtained by the Rev. J. M. Joass. The mineral is of a light yellow colour and encloses the ordinary plant remains common to these deposits.

No. 2 Sample, from Loch Osabhat, Lewes, was obtained from Mr. William Morrison, of Dingwall, who brought it from the deposit. The locality is described as covering the bottom of a drained loch (Loch Osabhat), and to be about 1½ acres in extent. The depth of the deposit is about 11½ feet, and after deducting about 4 feet of dark peaty stuff, we have about 7½ feet of the pure deposit. At the edges of the basin the deposit thins out to 1½ feet. When freshly cut the material gives off a disagreeable fœtid odour, but on drying the smell disappears and the colour changes from a dark brown to a light drab. Mr. Morrison calculates the bulk of the material at 7,500 square yards, which will be equivalent to about 10,000 tons weight. One cubic foot weighs about 54 lbs., which is equal to 13 cwts. per cubic yard. The loch was drained in 1874.

* *Trans. E. Geo. Soc.* Vol. IV. Pt. 3, and Vol. VI. Pt. 1.

No. 3 Sample is from Auchnerran, in the parish of Logie-Coldstone, Aberdeenshire; and

No. 4 Sample from Presswhin, Logie-Coldstone.

This latter deposit is at an altitude of 2,100 feet.

The *fifth sample* is of a dark brown, almost black, colour, very compact, and difficult to cut with the knife. It, however, contains a considerable proportion of organic matter; and, beyond the colour and the large proportion of iron present, it does not differ much from the other samples.

These compact masses give rise to considerable difficulty when the Diatomite is to be employed for dynamite manufacture; for during the preliminary process of roasting, to get rid of the organic constituents and water, these masses fuse and cause both loss of time and material. The large proportion of iron would not in itself be objectionable; for, as I have previously stated, the higher coloured dynamites are preferred by the miners—the colour being supposed to indicate strength,—but the fusibility of the mass renders the calcined residue worthless on account of its compact nature and small absorbing power. Kilns are now erected in Aberdeenshire, on the sites of these deposits; the iron nodules will be thrown aside, and a consequent saving of carriage effected. The market value of the Diatomite is about £4 per ton in the crude condition on truck at the nearest railway station. Kieselguhr fetches about £3 6s. per ton at the works.

The analyses of the samples are given in Tables A, B and C.

The Golspie sample contains a small proportion of organic constituents and corresponding increase of siliceous matter. It is, however, somewhat compact and not quite so absorbent as some of the other samples. Sand particles are also present, and although not in great quantity, would cause extra trouble and expense in purification preliminary to the use of the material either for dynamite or ultramarine.

The Loch Osabhat sample has a somewhat similar composition but is more open and porous, which, taken along with greater freedom from sand particles, renders the deposit of greater commercial value for an absorbent.

The Auchnerran sample is more of the character of the Black Moss and Kinnord samples described in my previous papers, having a considerable proportion of fibrous stems of reeds and water-plants embedded in the mass, which give binding power sufficient to allow of the body being "cast" like peats and regularly stacked to dry. These advantages in handling make this locality a valuable one, and, provided roads are available or the hill sides are sufficiently smooth for the peat sledge, then the material should be put in the market at a small cost. Moreover, the large proportion of

organic matter means that on calcination a more open and porous mass will be obtained, and a higher class absorbent. I look upon this Auchnerran deposit as one of the most valuable yet discovered. Even better, however, is the Presswhin sample, which, with fully ten per cent. less organic matter, is more open and porous than the Auchnerran material. It is also of a light drab colour, and has all the other characteristics of those Aberdeenshire deposits.

All of the above four samples yield to ether more or less chlorophyll, the green colouring matter of growing plants.

The last sample—the nodule from Kinnord—gives, on calcination, a bright red highly ferruginous ash, and, from the proportion of iron present, is very much more dense than any of the other samples and quite unfit to be used for either dynamite or ultramarine.

The proportion of diatomaceous matter is large in all the samples with the exception of that from Sutherland. This is a rather curious point, for this sample is one of the lightest in colour we have as yet had in our hands. On examination of the sample, however, it will be readily noticed that the iron, although not mixed throughout the mass, is concentrated in little particles, and has evidently been formed by the oxidation of spathic ore or from the decomposition of pyrites by means of organic matter. The Loch Osabhat sample is very similar in composition, and the remarks made as to the previous sample will be equally applicable to this deposit.

The agglomeration of iron as shown in the Kinnord nodule is interesting, and may point to a possible means of the formation of bog iron ore. It will be noticed that the other constituents of mineral origin are not in excess, and that even the allied alumina is small in quantity.

I have laid these few remarks before the Society in the endeavour to keep abreast of the age, and as proof of the statement made by me in my last paper that these deposits, although now of limited number and limited extent, only required the impetus of commercial value to lead to the discovery of fresh beds, and that from the various notices of diatomaceæ in the microscopical and other journals the localities would be neither few nor of small extent.

A.—Analysis of Samples as received.

	Lewes.		Aberdeenshire.			Ball from Kinnord Deposit, Aberdeenshire.
	Sutherland.	*Grest.*	Auchnerran.	Presswhin.		
Moisture	7·92		10·64	12·60	10·61	12·48
Organic Matter (Soluble in Ether) Chlorophyll	12·04	13·875	1·32	0·61	0·32	0·07
Organic Matter (Cellulose, &c.)			11·04	37·67	27·92	51·04
Inorganic Constituents	80·04	86·125	77·02	49·08	61·16	36·21
	100·00	100·000	100·02	99·96	100·01	99·80

B.—Analyses calculated free from Moisture.

Organic Matter Soluble in Ether, Chlorophyll, &c.	13·08	13·874	1·47	0·70	0·35	0·08
Organic Matter Cellulose, &c.			12·35	43·12	31·23	58·31
Inorganic Constituents	86·92	86·125	86·17	56·18	68·29	41·37
	100·00	99·999	99·99	100·00	99·87	99·76

C.—Analyses of Inorganic Portion.

	Sutherland.		*Grest.*	Auchnerran.		Presswhin.	Kinnord Ball.
I. *Soluble in Water.*							
Calcic Oxide	0·706						
Magnesic ,, ...	0·362						
Potassic ,, }	0·113						
Sodic ,, }							
Sulphuric Anhydride ...	0·011						
		1·192					
II. *Soluble in Hydric Chloride.*							
Ferric Oxide	8·841		1·326	6·323	1·047	0·889	16·726
Aluminic ,, ...	1·120		0·753				
Calcic ,, ...	2·379			0·325	0·443	0·206	0·963
Magnesic ,, ...	0·935						
Alkalies, &c.	0·226						
Soluble Silica	0·623						
		14·124					
III. *Silicates decomposed by Hydric Fluoride.*							
Ferric Oxide	0·442						
Aluminic ,, ...	0·516						
Calcic ,, ...	0·187						
Magnesic ,, &c. ...	0·098						
		1·243					
Silica, mostly Diatoms ...		82·638	94·495	90·367	96·574	95·725	37·321
		99·197					

Diatomaceous Deposits in Skye.

PART I.—DESCRIPTIVE. By J. S. GRANT WILSON, H.M. Geological Survey.

PART II.—CHEMICAL. By W. IVISON MACADAM, F.I.C., F.C.S., Professor of Chemistry, New Veterinary College, and Lecturer on Chemistry, School of Medicine, Edinburgh.

[Read May 21st, 1886.]

PART I.—DESCRIPTIVE.

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Introduction.

I. *The Diatomite of Cuithir.*—1. Topography. 2. Area of deposit. 3. Thickness. 4. Calculated number of tons of diatomite. 5. Diatomite found in ground above the swamp—water of loch probably stood at a higher level. 6. Quality and conditions under which deposit took place.

II. *The Diatomite of Loch Monkstadt.*—1. Topography. 2. Area of deposit. 3. Thickness. 4. Conditions prevailing during deposition.

III. *Other Localities where Diatomite has been found.*

INTRODUCTION.

IN the following pages we propose to give a short description of the recent discovery of diatomite in Skye. The portion of ground that has been explored for the deposit lies at the north end of the Island, and forms the estate of Colonel Fraser, of Kilmuir. The area is about 58 square miles, and within these limits the diatomite has been found in large quantities at two localities. As the situation of these and the conditions under which the deposition took place are in both cases very different, they will be described separately.

I. LOCH CUITHIR (QUIRE).

1. Topography.—The north end of Skye is divided into two nearly equal portions by a well-marked range of hills which trend north and south. The Sgurr Moor terminates this ridge on the north, while southwards from this point it presents a very bold escarpment to the east, and includes, among

numerous picturesque rock masses, the famous Quirang. This escarpment is almost entirely composed of beds of basalt and volcanic ash dipping gently to the west. On the north-east side of Creag-a-Lain the basaltic cliffs have succumbed more rapidly to the various denuding agencies that have been at work, and the result has been the production of a magnificent "corrie" almost circular in form. This depression is flanked by projecting masses of rock that have yielded more slowly to the agents that formed the rest of the escarpment. The centre of the corrie of Cuithir is occupied by a small loch of the same name. This sheet of water is small and shallow, and lies at the north-east edge of a well-marked circular depression, the remaining portion of which is a soft marsh. Below this marsh has been found the largest deposit of diatomite as yet discovered in Skye. The sides of this rock basin are from 15 to 20 feet above the level of the water, and every where the slope is steep and appears to be entirely composed of basalt. The various small streams that drain off the sides of the "corrie" enter the basin at the south-west corner, and the marsh in this direction continues for some distance between two of the burns.

2. Area of Diatomite Deposits.—The total area of the swamp and tarn, calculated from the ordnance 6 inch scale, is about 24 acres.

3. Depth of Diatomite.—In order to form an approximate idea of the thickness of the diatomite over the area, a borer 12 feet in length was used, and at the bottom of several of the bores an 18 foot iron rod was inserted, and in one case only did it touch the bottom; over portion of the marsh ground; it was impossible to put down any bores on account of the boggy nature of the surface. To the south-west of the lake 19 bores were put down with the following general results:— These bores proved the average thickness of the turf and peat lying above the diatomite to be 3 feet 8 inches. No intervening beds of sand or silt were met with, but the borer passed directly into diatomite and showed an average thickness of at least 8 feet 4 inches of that substance over the whole area bored. Further, the iron rod above-mentioned as 18 feet long was used to probe these bores, and in only one case, and that close to the edge of the basin, did it touch the bottom. Assuming, then, that the total depth is only 18 feet, this leaves a thickness of 14 feet 4 inches of diatomite. Future bores will no doubt show that the diatomite has a greater thickness than 18 feet, and this is rendered very probable by the uniform steepness of the sides of this basin. The flat ground beyond the circular basin and between the two burns was only bored to the depth of 12 feet, and nowhere was the bottom reached. The average thickness of peat cover was found to be 3 feet 10 inches, leaving 8 feet 2 inches of diatomite.

4. Calculated Number of Tons.—In working a similar deposit on Lord Aberdeen's estate at Tarland, it was found in practice that it took 6 cubic yards of the raw material to form a kiln-dried ton.* Calculated on this basis, and with a necessary allowance for shrinkage when the ground is drained, there are at least 72,000 tons of diatomite lying in this portion of the ground.

5. Diatomite found in Ground above the Swamp.—The flat between the burns is surrounded on the south and west sides by rough, hillocky ground, covered with heather, where diatomite has also been found. This portion of the deposit may be due to the small streams which empty themselves at this point into the swamp; or, on the other hand, the water of the loch may have stood at a higher level than it does at present. That this change of level has taken place is proved by the fact that a small patch of diatomite lies to the south of the large circular depression, and rests on the sharp rock slope that forms the side of the basin. The present outlet of the loch has a very artificial appearance, and if it were closed the surface of the water would be 15 feet higher than it now is, quite sufficient to submerge the greater portion of the rough ground.

6. Quality of Deposit.—The wet samples brought up by the borer showed that the top portion of the deposit had a bright green tint. This colour is due to chlorophyll and can be extracted by ether. A few feet down from the surface this colour usually changed to a light grey, or brown. When dried for some hours in an oven these different colours all disappeared, the samples either becoming chalk-coloured or creamy-white. The purity of this diatomite at Cuithir is very remarkable, as none of the bores show any intercalated bands of sand or silt, and the material itself contained no trace of grit. This freedom from any admixture of foreign matter is doubtless due to the position it occupies. The small streams that drain into the swamp are fed by springs which rise at the foot of the basaltic cliffs that form the walls of the "corrie." None of these streams run over peaty ground, so that the water during the period of deposition must have reached the lake in a state of great purity. The climatic conditions that prevailed during the time when the diatom forming plants flourished must have been peculiarly favourable to their growth, and in addition to the situation of the lake, sheltered on every side, must have contributed in no small degree to the accumulation of so large a deposit.

The streams all originating in springs, a constant amount of water would flow along them, and they would not be liable to sudden floods.

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* *Trans. Geol. Soc. of Edin.* Vol. IV. p. 210.

The best gathering places for living diatoms are usually to be met with where springs issue from the ground. It is probable, therefore, that a large proportion of the diatoms did not live in the loch, but existed in the springs and burns, and were only swept into the loch afterwards. The "corrie" being almost destitute of any drift-deposit, the only foreign matter carried down by the burns consists of rock detritus, and this has been precipitated at once in the form of cones when they entered the basin before the present partial drainage of the loch. The diatoms, from their minute size and consequent lightness, would be much longer held in suspension, and thus distributed equally over the rock basin. The diatomite of Loch Cuithir was also found to contain fewer species of diatoms than similar deposits in Skye, where there is a considerable admixture of foreign matter. The fewer number of species obtained from Cuithir is doubtless due to the more equable conditions kept up by the springs which fed the loch.

The covering of peat that now lies above the diatomite has grown since the lowering of the surface of the water. When this took place there would only remain a few feet of water above the diatomite, and the various peat-forming plants and mosses with their rapid growth would soon convert the crystal clear lake into its present condition of swamp and tarn.

II. Loch Monkstadt.

1. Topography.—To the north-west of Cuithir and in close proximity to the western seaboard lies the site of what was once the Loch of Monkstadt. A good many years ago the loch was drained by a large ditch which was cut from sea level at Camas More to the northern edge of the loch, a distance very little short of a mile. The former site of the loch, about 70 feet above sea level, is now a large flat of fairly well drained ground, all under pasture, and about half a square mile in extent. In outline it forms a rough triangle, with its apex pointing to the south-east and its base facing the north-west. Through the centre of this meadow land runs the main drainage level, and alongside this a series of bores were put down.

Thickness.—These showed that the deposit of diatomite occurred in a very irregular manner. At the south end of the flat it was almost entirely wanting, and when present was very much mixed with sand and mud. In a drain to the north of the old ruins of the monastery, about 1 foot 6 inches is seen immediately below the surface, and from this point to the north-west corner of the loch its position was proved by boring. The cover of mud, turf and peat varies in thickness from 1 to

5 feet, with a corresponding range in the thickness of the diatomite. The deposit is sometimes mixed with fine mud and silt, and in one instance a bed of sand occurs in the centre of 3 feet of diatomite.

Conditions prevailing during the Deposition of the Diatomite.—The water that drains into the loch enters at the south-east corner by several burns. These all flow off or through peat, and this is evidently the reason why the diatomite, when present over the upper portion of the basin, is always mixed with fine silt or mud. The area between the old monastery and the north-west corner would be the part farthest removed from the disturbing influences, and it is here that the diatomite is found in its greatest thickness and purity. As compared with Cuithir, the quality of the Monkstadt deposit is inferior, but it is quite equal to the German supply from the "Kieselguhr." Samples from the various bores all contained a little grit and particles of mica. When these were dried they had a darkish grey colour, and in proportion were much heavier than similar specimens from Cuithir.

III. Other Localities where Diatomite has been found.

Loch Mealt.—Very good diatomite has been found under the marsh ground that fringes the western margin of the loch. It is covered with 10 feet of peat close to the edge of the water, and between this point and the landward side of the marsh a thin covering is spread over the rocky bottom as it rises shorewards.

Sartil.—The locality is situated two miles to the west of Staffin, on the Uig Road, and the deposit is a very irregular one. The diatomite is found in rough, hillocky ground, very similar to that surrounding a portion of the swamp at Loch Cuithir.

Loch Cleat is a small loch lying to the east of Duntulm Bay. Diatomite of very good quality has been got below the swamp that borders the lake.

Loch Snuisdale.—This loch lies midway between Monkstadt and Cuithir, and diatomite has been found below a peat-moss a little to the west of the loch, and about 500 feet above sea-level.

Glen Uig.—A small deposit on the right hand of the glen. The diatomite lies on a slope and is of no extent.

Part II.—Chemical.

The annexed table of analyses shows the chemical composition and absorptive value of the samples obtained from the various deposits.

With the single exception of the No. 1 Monkstadt sample, the proportion of organic matter is small, being only 4½ per cent. of the dried

Diatomite—Skye.

I. *Analysis of Sample as received:—*

	"Quire." No. 1.	"Quire." Edge.	"Quire." Centre.	"Sartil." ——	"Loch-snuisdale." ——	"Monk-stadt." No. 1.	"Monk-stadt." No. 2.	"Uig." ——
Moisture	6·921	8·240	6·405	8·466	7·417	10·106	8·602	8·164
Organic Matter... ...	4·246	9·690	4·149	7·134	4·291	20·685	10·402	10·463
Ferric Oxide	2·679	1·271	0·673	3·079	7·189	8·211	4·367	3·511
Lime, &c.	0·521	0·805	0·041	0·685	3·525	3·746	0·854	0·501
Silica (diatoms) ...	85·633	79·994	88·732	80·636	77·578	57·252	75·775	77·361
	100·000	100·000	100·000	100·000	100·000	100·000	100·000	100·000

II. *Calculated free from Moisture:—*

Organic Matter ...	4·561	10·560	4·432	7·794	4·634	23·010	11·381	11·393
Ferric Oxide	2·878	1·385	0·719	3·363	7·753	9·134	4·778	3·823
Lime, &c.	0·559	0·877	0·043	0·748	3·807	4·167	0·934	0·545
Silica (diatoms) ...	92·000	87·177	94·804	88·094	83·792	63·686	82·906	84·238
	99·998	99·999	99·998	99·999	99·986	99·997	99·999	99·999

III. *Results after Calcination:—*

Ferric Oxide	3·015	1·548	0·752	3·647	8·142	11·864	5·391	4·314
Lime, &c.	0·585	0·980	0·045	0·811	3·992	5·412	1·054	0·615
Silica (diatoms) ...	96·397	97·469	99·200	95·540	87·865	82·723	93·554	95·069
	99·997	99·997	99·997	99·998	99·999	99·999	99·999	99·998

IV. *Absorptive Value:—*

100 parts of Calcined Material become when saturated with water ...	369	356	397	284	327	359	266	301

material, as obtained from Quire and Lochsuisdale, 7¾ per cent. in Sartil, and from 10 to 11 per cent. in the Monkstadt No. 2, in Uig, and at the side of Quire deposit.

Ferruginous impurity is practically absent in the central part of the Quire deposit (0·71 per cent.), but at other parts of the same basin the quantity was found to be from 1·3 to 2·8 per cent. In the remaining deposits we find 3·3 per cent. in Sartil, 3·8 per cent. in Uig, 7·7 per cent. in Lochsnuisdale, and from 4·7 to 9·1 per cent. in Monkstadt.

The value of the material for absorbing fluids such as nitro-glycerine is also high. 100 parts of the calcined substance take up of water from 166 parts to 297 parts, or from 1½ to 3 times its weight.

The Quire central zone will be found to be very valuable for the manufacture of ultramarine, and other uses where iron is objectionable, whilst the freedom from sharp sand renders the remaining deposits valuable for the various manufactures where a small proportion of iron is not objectionable.

On the Chemical Composition of the Mineral Bruiachite, found by Mr. Thomas D. Wallace, of Inverness, at Loch Bhruithaich, Inverness-shire.

By W. Ivison Macadam, F.I.C., F.C.S., Professor of Chemistry, New Veterinary College, Edinburgh.

[Read May 21st, 1886.]

In a paper read before this Society on June 16th, 1885,* Mr. Wallace drew attention to this mineral as being found at Loch Bhruithaich, and stated that it was obtained incrusting Barytes.

The mineral is clear, beautifully crystalline, with a tendency to a bluish tinge of colour, and very friable.

The analyses gave the following results as the average of six tests :—

Calcic Oxide ...	87·045
Sodic ,, ...	1·697
Ferric ,, ...	0·595
Fluorine	10·006
Silica	0·542
	99·885

We propose to call this mineral Bruiachite.

* *The Mineralogical Magazine and Journal of the Mineralogical Society*, Vol. VI. page 169.

Abstracts and Notes.

Vom Rath (*Festschrift des Ver. für Naturkunde.* Cassel, 1886) describes another crystal of the Quartz from Alexander Co., N. Carolina, which has been the subject of a previous paper by him (see this Journal, Vol. VI. p. 146). The crystal is compounded of two left-handed individuals, and bears a number of new faces. Five of these are in the zone *yr*, that is to say between the faces 5 P $\frac{5}{4}$ = (10 . $\bar{2}$. $\bar{5}$) and R = (100); two in the zone between R = (100) and ∞R = (11$\bar{2}$); and there are also several other new faces which do not lie in the principal zones, but belong to the group called "faces isolées" by Des Cloizeaux.

A second paper by the same author deals with the Andesite from Mount Arcuentu, in Sardinia. This mineral has an axial angle γ of almost exactly 90°, so that it occupies a mean position between Albite and Anorthite; and it was found to be twinned in accordance with no less than four laws, one of which is perhaps new. They are (1) the "Albite law," *i.e.* twin axis normal to the brachy-pinakoid, composition parallel to that face; (2) the "Carlsbad law," *i.e.* twin axis the prism edge or vertical axis, composition parallel to the brachy-pinakoid; (3) the "Pericline law," *i.e.*, twin axis the macro-diagonal, so that the individuals interpenetrate and unite in the Rhombic Section, of which the significance was pointed out by Prof. vom Rath in 1876; and (4) twin axis the brachy-diagonal, composition parallel to the basal plane. The last has been mentioned by Des Cloizeaux in his *Manuel de Minéralogie*, but was based upon doubtful evidence in the cases referred to by him; the law is to be regarded in all probability as characteristic of Andesite.

A. Renard (*Bull. Ac. Belg.* IX. p. 547) examines the optical characters of Ludwigite with the polarising microscope, and concludes that it is strongly dichroic, that it is biaxial and probably crystallises in the orthorhombic system, and that the plane of the optic axis is perpendicular to the direction in which the fibres are extended.

E. Rethwisch (*Neues Jahrb.* IV. *Beilage Band*, p. 31) gives a complete summary of the facts which have been at present published concerning Red Silver, including a list of the literature, a full table of crystallographic forms with their angles, and a history of the chemical work which has been done upon the mineral: to this are added four new

analyses, accompanied by crystallographic measurements of the specimens analysed, as follows:—

	Percentage of Arsenic.	Rhombohedron Angle.	Specific Gravity.
Pure Proustite from Chanarcillo	15·03	72°10′10″	5·5553
Pyrargyrite from Andreasberg ...	3·01	71°22′27″	5·716
Pyrargyrite from Freiberg	2·62	71°21′30″	5·754
Pure Pyragyrite from Andreasberg	0	71°12′58″	5·871

E. Scacchi (*Atti Acad. Lincei*, II. p. 182) describes crystals of Garnet from Tiriolo, in Calabria, dodecahedra having their edges truncated by the icositetrahedron {211}, while the edges made by faces of the latter with the dodecahedron faces are bevilled by the forms {431} and {541}; of these the latter is not only new for Garnet, but was not hitherto observed on any mineral belonging to the cubic system.

E. Scacchi (*Atti Acad. Lincei*, II. p. 183) gives a crystallographic and chemical determination of altered Cordierite (pinite) which occurs in liparite at Rocca Tederighi, in Tuscany. The mineral is found in green prisms from 3 to 8 mm. in length, which are a combination of the pinakoids, and two prisms, the basal plane, two pyramids, and a brachydome. As the mean of two analyses the author obtained—

SiO_2	49·65
Al_2O_3	27·41
Fe_2O_3	8·89
CaO	3·95
MgO	1·23
H_2O	8·38
	99·51

so that the mineral may be called a normal Pinite; the measured angles agree approximately with those of Des Cloizeaux.

The Theory of Twins. (*Bull. Société Minéralogique*, VIII. p. 452).—M. Mallard considers twin-crystals under the two distinct heads of (1) *Juxtaposition twins* or *macles*, in which the union is along a plane of the crystal; (2) *Interpenetration twins*, in which the individuals generally pass into one another and may have no regular surface of union. His method of regarding twins is based upon a distinction between the *point-system* (*système réticulaire*) or geometrical network formed by points occupying the positions of the centres of mass of the crystal molecules, and the

molecule-system (*édifice crystallin*), or actual crystalline network in which the points of the reticular system are replaced by the properly orientated molecules. The two semi-forms derived from a crystal form are supposed to have the same point-system but different molecule-systems, in other words their molecules occupy similar positions but have different orientations.

The following general laws are then enunciated—(1) Juxtaposition-twins; *the reticular systems of the component crystals are symmetric about the twin-plane;* here two cases may arise, (*a*) in holohedral crystals the twin-plane is a plane of actual symmetry; (*b*) in hemihedral crystals the molecule systems may be either the same or complementary; that is to say, according to the orientation of the molecules to a semi-form on one side of the twin-plane will correspond either the same or the complementary semi-form on the other; the twins may therefore be either symmetric or non-symmetric. M. Mallard proposes to abandon the idea of hemitropy, since to describe a twin it is enough to indicate the twin-plane, and to state whether the growth is symmetric or non-symmetric. (2) Interpenetration twins; here one crystal is derived from the other by turning through a certain angle about a crystal line as axis, and the general law is laid down that *this axis is always an axis of abortive symmetry or of pseudo-symmetry;* in other words, the individuals in their positions of intergrowth have either the same or nearly the same point-system.

Finally, a physical explanation of the phenomena is offered to the following effect. It may be assumed from the character of interpenetration twins that the internal equilibrium depends essentially upon the position of the molecules and not upon their directions; this being the case, we must suppose that the twin plane of a "macle" is *one along which two consecutive layers of molecules can have two very different positions of equilibrium*, account being had to the *positions* of the molecule alone.

The process of twinning is then illustrated by the action which takes place in the artificial twins of Calcite, as produced by Reusch. Just as in the latter layers of molecules parallel to the obtuse rhombohedron can be made to slide over one another and adopt a new position of equilibrium, so in the natural twinning of any mineral a crystal plane may by some accident be deposited in its second (or twin) position of equilibrium. Upon this the second crystal may then be developed either in parallel or twin position; in the latter case it must be assumed that the displacement of the plane is accompanied by a suitable change in the orientation of the molecules. The twin plane is generally one of simple indices, in other

words of great reticular density or parallel to a system of planes which are relatively widely separated from one another.

M. E. Mallard (*Bull. Société Minéralogique*, IX. p. 54) reviews the objections which have been brought against the theory of the optical anomalies of crystals propounded by him 10 years ago, and criticises the alternative theories which have been advanced by Klein, Rosenbusch, and others.

In defending his own views the author contends that in those cases where the optical properties of different parts of a crystal are the same with different positions, in other words where they can be referred to the same ellipsoid of elasticity, only differently orientated (*e.g.* in Uwarowite and Boracite), his theory is simply a translation of the observed facts into crystallographic language. Where, on the other hand, the different parts cannot apparently be referred to the same ellipsoid, but seem to be optically distinct, their dissimilarity is to be explained in accordance with the theory as due to the overlapping of a number of parts differently orientated, each belonging to one of the individuals which, by their regular intergrowth, build up the crystal. This the author supposes to be the case with Perofskite and Analcime.

As regards the alternative theories—some investigators trace the double refraction of cubic crystals and the other anomalies to internal tensions due to shrinkage on cooling; this view is condemned by the facts (1) that the transition between dissimilar parts is not gradual, as it should be if there is internal equilibrium, and as it is in the case of unannealed glass; and (2) that these effects of cooling can only be produced experimentally in precisely those substances which are not crystalline, viz. glass, gelatine, &c.

C. Klein has supposed that when Boracite crystallises an external shell is first formed, and that this exerts a pressure upon the internal crystalline material; to which M. Mallard replies that in this respect all crystals would be expected to behave in the same way. Brauns has suggested that internal tensions are produced by the mutual action of different but isomorphous molecules united in the same crystal; in answer to which it is objected that many substances which are undoubtedly isomorphous mixtures exhibit no optical anomalies. Latterly Klein has considerably modified his views, and in certain cases accepts the explanation of Mallard as describing the present structure of crystals whose original constitution is only indicated by their condition at high temperatures; Boracite, for instance, is regarded by him as at present orthorhombic, but originally cubic (see this Journal, Vol. VI. p. 193). Such a view, however, raises the question why, if the substance was not essentially orthorhombic, the

component crystals have only six different orientations, namely those corresponding to the six binary axes of the cube. Rosenbusch holds yet another opinion, and regards crystals of Leucite at the ordinary temperature as in a state of tension due to their incipient passage from the original cubic structure to a new stable molecular arrangement which is still unknown to us, so that in their present condition they are scarcely true crystals. Mallard, on the other hand, supposes that Leucite behaves in the same way as Boracite, the only difference being that twin lamellæ are in the former produced more easily and in greater number than in the latter.

Under the name of *Arsenolamprite*, Dr. C. Hintze, of Bonn, describes (*Zeits. f. Min.*, Vol. XI., 1886, 638), a mineral which he regards as identical with the so-called *arsenglanz* of Breithaupt, but which has not been hitherto looked upon as possessed of sufficiently distinctive characters to rank as a species. Analyses of two specimens yielded Dr. Klinger :—

Arsenic	98·14	98·43
Iron	1·92	1·00
Silica	0·55	0·05
	99·61	99·48

Density =5·80; taken by pycnometer, 5·54, which latter corresponds to that given by Breithaupt to the Saxony mineral. This, however, contained bismuth, which is absent in these specimens from Chili. Hardness, slightly more than that of gypsum. Lustre, bright metallic, hence its name, from λαμπρό = shining, structure foliated columnar, with a well-defined cleavage; colour, lead-grey inclining to bluish; streak, black. The author considers from its single cleavage that it is certainly not cubic in its crystallisation, and it is improbable that it should be rhombohedral or tetragonal, and that it may belong to one of the three other systems. It differs from rhombohedral arsenic in lustre, density, hardness, and structure, and may be a special modification of arsenic, comparable to the two forms of carbon, viz. graphite and diamond.

A New Mineral and a New Element.—In the year 1885, a rich silver ore of unusual appearance was found at the Himmelsfürst Mine, Freiberg, Saxony. A. Weisbach marked it as a new species and named it Argyrodite. According to a blowpipe examination by Th. Richter, it contained a small amount of mercury, but which Winkler, who analysed it (*Ber. d. Deutsch. Chem. Ges.*, 19te Jahrg., No. 3, p. 210), showed to be only 0·21 per cent. He was, however, in each analysis confronted with a loss of from 6 to 7 per cent., which could not be accounted for. After much troublesome research he was enabled to announce the discovery of a new metallic

element which he has named *Germanium*. Weisbach (*Neues Jahrb. f. Min.*, 1886, B. II. p 67) gives the following characters of this new and interesting species. Lustre, metallic; colour on crystal-faces steel-grey on a fresh fracture, and to reddish, and sometimes violet as in Erubescite; streak, grey-black, shining; opaque. Hardness, 2·5, specific gravity 6·085 to 6·111; brittle; crystals show no cleavage; fracture, somewhat conchoidal. Crystallises in the monoclinic system, sometimes in twins and "three-lings," but mostly very minute and indistinct, being frequently aggregated in wart-like and kidney-shaped groups. The analysis showed 75 per cent. of silver and 7 per cent. of germanium, which is to be represented by the symbol Ge.

G. Flink (*Zeits. f. Kryst.*, XI., 1886, pp. 449-530) draws the following conclusions from an elaborate study of the Pyroxene minerals of Sweden.

In the varieties of Diopside it is proved for the first time that an increase in the proportion of iron is always associated with a regular increase in the axial angle β, which varies from 74°34¾′ in those which are richest in iron to 74°12¾′ in those which contain least iron; on the other hand, the examination of Schefferite and Rhodonite shows that the presence of manganese has precisely the opposite effect, and to a much greater degree. Thus:—

	MnO per cent.	β
Diopside	0·00	74°11′
Schefferite	8·32	73°53′
Rhodonite	41·88	71°15¾′

When the proportion of manganese exceeds a certain amount, the system changes from oblique to anorthic (Rhodonite), though it is not yet ascertained what is the exact percentage of manganese for which the transition takes place.

The author has also studied the corresponding variations in the optical characters of these minerals, and finds that in this respect manganese and iron have the same effect, an increase in the percentage of either serving to increase the extinction angle in the plane of symmetry (angle between acute bisectrix and vertical axis) and also the angle of the optic axes. Since, however, the optical orientation of the anorthic Rhodonite is totally different from that of the oblique Pyroxenes, no direct comparison can here be made between the two groups.

One portion of the paper deals with well crystallised Schefferite from Längban and Pajsberg; the name Schefferite is used to denote those oblique Pyroxenes which are characterised by a high percentage of manganese.

EXCERPT MINUTES OF COUNCIL MEETING

Held at the Museum, Jermyn Street, December 8th, 1885.

A letter was read from Mrs. Greg, informing the Council that her husband, Mr. R. P. Greg, wished to be relieved of the duties of the Treasurership.

The Hon. Sec. was requested to communicate to Mrs. Greg the sincere regret of the Council that the state of Mr. Greg's health compelled him to resign.

Prof. T. G. Bonney, D.Sc., F.R.S., was elected Treasurer.

EXCERPT MINUTES OF COUNCIL MEETING

Held at 116 Victoria Street, January 26th, 1886.

The audited Balance Sheet for the year 1885 was submitted and ordered to be printed (p. V.).

EXCERPT MINUTES OF COUNCIL MEETING

Held at 116 Victoria Street, May 10th, 1886.

The following Members were elected—

William E. Dawson, Analyst & Assayer to the Government of the S.A. Republic, Pretoria.

William Boxhall, Treverbyn, St. Austell.

Dr. Victor Goldschmidt, Vienna.

C. R. Lindsey, B.Sc., 69 West Worsley Street, Salford.

Carl Adolph Moberg, Director of the Geological Survey of Finland, Helsingfors.

GENERAL MEETING.

Held at the Museum, Jermyn Street, December 8th, 1885.

L. Fletcher, M.A., President, in the Chair.

The following papers were read:—

Rev. Prof. Bonney. "On a Glaucophane-eclogite from the Val d'Aoste." (p. 1.)

H. A. Miers, M.A. "Note on Orthoclase from Kilima-njaro." (p. 10.)

Mr. Miers also exhibited some peculiar twins of Calcite from Eyam, Derbyshire.

R. H. Solly, F.G.S. "Preliminary Notice of Penetration Twins of Arragonite from New Mexico."

Prof. W. J. Lewis. "On some specimens of Idocrase and Garnet from the neighbourhood of Zermatt." (p. 9.)

Dr. Burghardt exhibited some pseudomorphs of Native Copper after Arragonite from South America.

GENERAL MEETING.

Held in the Chemistry Class Room, United College, St. Andrew's, on Friday, May 21st, 1886.

Prof. M. F. Heddle, Past President, in the Chair.

The following papers were read :—

Andrew Taylor, F.C.S. "On the Nomenclature of the Hydrocarbon Compounds, with a suggestion of a new classification." (Communicated by the Local Secretary.) (p. 13.)

Prof. W. Ivison Macadam, F.C.S. "On new localities for Diatomite." (p. 30.)

J. S. Grant Wilson and W. Ivison Macadam. "On Diatomaceous Deposits in Skye." (p. 35.)

W. Hamilton Bell, F.G.S.E. "On new localities for Agalmatolite, with notes on its composition." (Communicated by the Local Secretary.) (p. 24.)

Mr. Bell's Paper.

Professor Macadam, in reply to the remarks of Professor Heddle, stated that all care had been taken in picking the specimens for analysis, that the picked substance had been placed below the microscope and no quartz was visible. He was of opinion that the substance had been produced under conditions favourable to the formation of Agalmatolite, but that the amount of Silica present was in excess of that necessary for the production of a body with a composition exactly similar to Agalmatolite as found at Kean-na-binn and Lua-Yayi. In regard to the statement that these opinions were equivalent to the naming of the body as a new mineral, Professor Macadam objected to such a course, and stated that in his opinion the multiplication of names for mere varieties should be discouraged, and suggested that to call the body a *Siliceous Agalmatolite* was sufficient, whilst it was descriptive of the composition of the body.

Prof. W. Ivison Macadam. "On a new locality for Agalmatolite." (p. 29.)

John F. Kerr, F.G.S.E. "The Metallic Ores of Chili." (Communicated by Professor Macadam.) (p. 18.)

Prof. W. I. Macadam. "On the Chemical Composition of the Mineral found by Mr. Wallace at Loch Bhruithaich, Ross-shire." (p. 42.)

Prof. Macadam read the following:—

Note on Serpentine from Creag Mhòr Thollie, Ross-shire.

By W. Ivison Macadam, F.I.C., F.C.S., &c., Professor of Chemistry, New Veterinary College, Edinburgh.

Very fine specimens of Serpentine were obtained from the Creag Mhòr Thollie, Loch Maree, Ross-shire. The material is very pure, of fine colour, and occurs in considerable abundance. The analysis is not yet completed.

The following notice was read:—

Notice of Mica Trap from Farley near Beauly,

By Thomas D. Wallace, F.G.S.E., Rector, High School, Inverness. (Communicated by Professor W. Ivison Macadam.)

This dyke of Mica Trap can be traced for miles from Muir of Ord westwards, towards Struy. Specimens were submitted to Mr. Horne of H.M. Geological Survey, and the following note was supplied by him:—

The microscopic examination of this rock shows that it belongs to the Mica-Trap group ; the two prominent constituents being dark brown mica and felspar. Of these, the dark brown iron magnesia mica or biotite is the most abundant, and when examined with the analysing prism is markedly dichroic. In some instances the plates of mica show indications of having been subjected to strain, but there is no trace of schistosity in the section or in the hand specimen. The felspar crystals have undergone alterations, but they seem to be partly orthoclase and partly plagioclase.

According to the most recent classification, the mica-trap group is divided into two rock species according to the nature of the felspar. If the latter be orthoclase the rock is termed minette, if plagioclase then it is named Kersanton or Kersantite.

Fresher specimens from this dyke would help to solve the question to which of these species it more properly belongs.

Along with these constituents there is some Apatite in well defined six-sided prisms.

An excursion was made in the afternoon to the Spindle Rock, and points of interest were shown and described by Prof. Heddle.

Mineralogical Society—Abstract of Receipts and Payments from 1st January to 31st December, 1885.

RECEIPTS.

	£	s.	d.
Balance from year 1884	0	1	0
Subscriptions paid in advance	2	2	0
,, for current year	87	17	0
,, Arrears	9	14	0
Entrance Fees and Life Compositions	25	4	0
Sale of Publications	8	2	4
Dividends	5	5	3
Prepayment of Postage	0	0	6
	£138	6	2

PAYMENTS.

	£	s.	d.
Printing	66	4	5
Illustrations	5	4	0
Expenses of Meetings	3	2	2
Editorial and Clerical Expenses	23	13	6
Postages, Parcels, &c.	12	10	10
Investments	12	5	3
Cheque Book	0	5	0
Balance	15	1	0
	£138	6	2

Examined and compared with the vouchers and found correct. (Signed)

BENEDICT KITTO,
F. W. RUDLER, } Auditors.

Assets and Liabilities *on 31st December*, 1885.

LIABILITIES.

	£	s.	d.
Williams & Strahan, Printing	22	15	6
Museum of Practical Geology, Gas, &c.	2	12	6
Editorial Expenses, 1885	10	10	0
Small Accounts (Advertisements)	0	15	9
Subscriptions paid in advance	2	2	0
Excess of Assets over Liabilities	241	4	3
	£280	0	0

ASSETS.

	£	s.	d.
Subscriptions for 1885 unpaid	24	8	0
,, 1884 ,, ...	8	2	0
New 3 Per Cents. £191 17s. 7d. at 99⅞	191	12	9
Stock of Publications (average yearly sale)	22	16	9
Simpkins & Co., Sale of Publications	17	4	6
Sale of Publications by Office—unpaid	0	15	0
Cash in hand and at Bank	15	1	0
	£280	0	0

Examined and compared with the vouchers and found correct. (Signed)

ROBERT H. SCOTT,
General Secretary.

MINERALOGICAL SOCIETY.

DONATIONS TO THE LIBRARY.

From January 1st to June 30th, 1886.

On Precious Stones, extracted from the "Mineral Resources of the United States" for 1883-4; On Meteoric Iron from Jenny's Creek, Wayne Co., West Virginia; On Three Masses of Meteoric Iron from Glorieta Mountain; Extracts from Notes on the Bement Collection of Minerals; "Science" for May 30, 1884, containing an Article on Brazilian Diamonds; and several leaflets; all by G. F. Kunz. Presented by the Author.

The Harz Mountains; their Geological Structure and History. By Henry Mowbray Cadell, B.Sc. Presented by the Author.

On the Mineral hitherto known as Nepaulite. By F. R. Mallet, F.G.S. Presented by the Author.

On Slaty Cleavage and Allied Rock-structures, with special reference to the Mechanical Theories of their Origin. By Alfred Harker, M.A., F.G.S. Presented by the Author.

A Few Facts about some Stones, Minerals and Crystals; and a Few Words on Carbon as a Turning Tool. By A. P. Bower. Presented by the Author.

Transactions of the North of England Institute of Mining and Mechanical Engineers. Vol. XXXV., Parts I. and II. Presented by the Institute.

The Naturalist, from Jan. to June, 1886. Presented by the Editor.

The American Journal of Science, from Jan. to June, 1886. Presented by the Editors.

Proceedings of the Canadian Institute, Vol. XXI. No. 142. Presented by the Institute.

Summary Report of the Geological and Natural History Survey of Canada. Presented by the Survey.

Mineral Resources of the United States for 1883-4. By A. Williams, Jun. Presented by the U. S. Geological Survey.

Bulletins of the U. S. Geological Survey. Nos. 15 to 23. Presented by the Survey.

Report of the Smithsonian Institution for 1884. Presented by the Institution.

The American Chemical Journal, Jan. to June 1886. Presented by the Editors.

Handbuch der Mineralchemie, Ergänzungsheft zur zweiten Auflage. Von C. F. Rammelsberg. Presented by the Author.

Ueben die chemische Natur des Eudialyts. Von. C. Rammelsberg. Presented by the Author.

Krystallographische Beobachtungen an organischen Verbindungen. III. Forsetzung. Von Dr. O. Luedecke. Presented by the Author.

Beobachtungen an Stassfurter Vorkommnissen (Pinnoit, Pikromerit, Kainit and Steinsalz). Von Dr. O. Luedecke. Presented by the Author.

Annalen des K. K. Naturhistorischen Hofmuseums. Redigirt von Dr. Franz Ritter Von Hauer. Band I., Nos. I. II. Presented by the Editor.

Jahrbuch der K. K. Geologischen Reichsanstalt, Band XXXVI., Heft. I.; and Verhandlungen der K. K. Geolog. Reichsanstalt, Nos. 16 to 18, 1885, and Nos. 1 to 7, 1886. Presented by the Institute.

Mineralogische und petrographische Mittheilungen. Herausgegeben von G. Tschermak. Neue Folge, Band VII. Hefte IV. and V. Presented by the Editor.

Annales de la Société Géologique de Belgique. Tome douzième.
Presented by the Society.

Bollettino del R. Comitato Geologica d' Italia. Nos. 11 and 12, 1885, and Nos. 1 to 4, 1886. Presented by the Survey.

Atti della Società Toscana di Scienze Naturali, Memorie, Vol. VII.; Processi Verbali, Vol. V. Presented by the Society.

Annales de la Sociedad Cientifica Argentina. Tomo XXI., Parts 1 and 2; and Examen de la Propuesta y Proyecto del Puerto del Sr. D. Eduardo Madero. Por Luis A. Huergo. Parts 1 and 2; Buenos Ayres, 1886.
Presented by the Scientific Society of the Argentine Republic.

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	English Mechanic	332 Strand, W.C.
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Leeds.	Yorkshire Naturalists' Union	W. D. Roebuck, Sunny Bank.
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Newcastle-upon-Tyne.	North of England Institute of Mining Engineers.	

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Pisa.	Società Toscana di Scienze Naturali.
Rome.	Ufficio Geologico, S. Susanna.
Bonn.	Zeitschrift für Krystallographie und Mineralogie, Dr. C. Hintze, Lennestrasse 37.
Vienna.	K. K. Geologische Reichsanstalt.
	Mineralogische und Petrologische Mittheilungen.

AMERICA.

Baltimore, Maryland.	The Johns Hopkins University (Publication Agency).
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Newhaven (Conn.)	American Journal of Science and Art.
Philadelphia.	Academy of Sciences.
Washington.	Smithsonian Institution (Agent, Wesley & Co., 28 Essex Street, W.C.)
	U.S. Geological Survey, Department of Interior.

AUSTRALASIA.

Sydney.	Technological Museum.
	Royal Society of New South Wales.
Wellington, N.Z.	New Zealand Institute.

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